

Technical Memorandum 2 – Projections and Options

South Lexington Transportation Study

Lexington, Massachusetts

Engineering and Planning Departments


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FAY, SPOFFORD & THORNDIKE

With RKG Associates, Inc.

January 2015

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2.1 INTRODUCTION

2.1.1 OVERVIEW

The Town of Lexington retained Fay, Spofford & Thorndike, LLC, and (FST) to conduct a South Lexington Transportation Study.

Overall, this study provides an operational analysis of walking, biking, and motor vehicle modes under existing and future traffic conditions with recommendations for additional enhancements. Study findings are being coordinated with the Town as well as community residential and business growth area stakeholders.

Technical Memorandum 2 follows up on Technical Memorandum 1 (Existing Conditions) by identifying 10-year horizon traffic projections pertaining to infill of existing approved developments with anticipated background growth to estimate a moderate and high development growth scenarios in the Study Area. Moderate and high development scenarios were identified by RKG, our Economic Development consultant. After consultation with the Town of Lexington, it was agreed to identify the high development scenario on an assumption that allows the Town to have a general idea about how much additional development can conceivably be absorbed on the Hayden Avenue/Spring Street/Concord Avenue/Waltham Street corridors before a major congestion problem emerges.

As requested by the Town, the *moderate* or conservative development scenario assumes that *approved* development expansions at 100/600 Shire Way and at 97 Hayden Avenue (Three Ledgemont) are fully constructed and occupied and that background traffic grows in accordance with projections of the regional model by the Central Transportation Planning Staff (CTPS). CTPS projects background traffic to grow approximately 2% in the South Lexington Study Area between 2012 and 2022.

Included in the analysis are *programmed* infrastructure changes as well as alternatives for *non-programmed* infrastructure changes associated with the base-case and high-end development assumptions as they pertain to the developments and its surrounding neighborhoods.

Figures 2.1-2.3 summarize a few of the displays from the Technical Memorandum 1 analyses. Figure 2.1 identifies the South Lexington Study Area and the 15 intersections where traffic counts were performed and analyzed. Figure 2.1A identifies the Study Area with the intersections where signals or pedestrian flashers are provided. Figure 2.2 summarizes South Lexington year 2013 transportation system focus areas and issues. Figure 2.3 identifies commercial development parcels and those where development expansions have been approved but not yet constructed. Approved additional new South Lexington development parcels generally are either immediately west of or immediately east of the Hayden Avenue at Spring Street intersection. Recent changes in the status of developments in the Ledgemont parcel may slow changes in the area, but programmed growth within the next ten years is still assumed. Figure 2.4 illustrates existing lane configurations of the road network evaluated.

The 10-year horizon addressed in this memo examines South Lexington Study Area office/commercial areas that have already largely been constructed and occupied. A range of alternative potential safety and congestion improvements is provided for identified problem areas, as well as an assessment of the environment for pedestrians and bicyclists within the context of pedestrian generators like parks, trails, and schools within the area.

Specifically, this Technical Memorandum examines the cumulative impacts of the Hayden/Spring Streets development areas projected during the next 10 years.

The Town of Lexington seeks to improve its pedestrian, bicycle and vehicular safety environment while improving overall traffic operations such that future economic development along the Hayden Avenue and Spring Street corridors is adequately accommodated *without adversely affecting the quality of life* in nearby residential neighborhoods

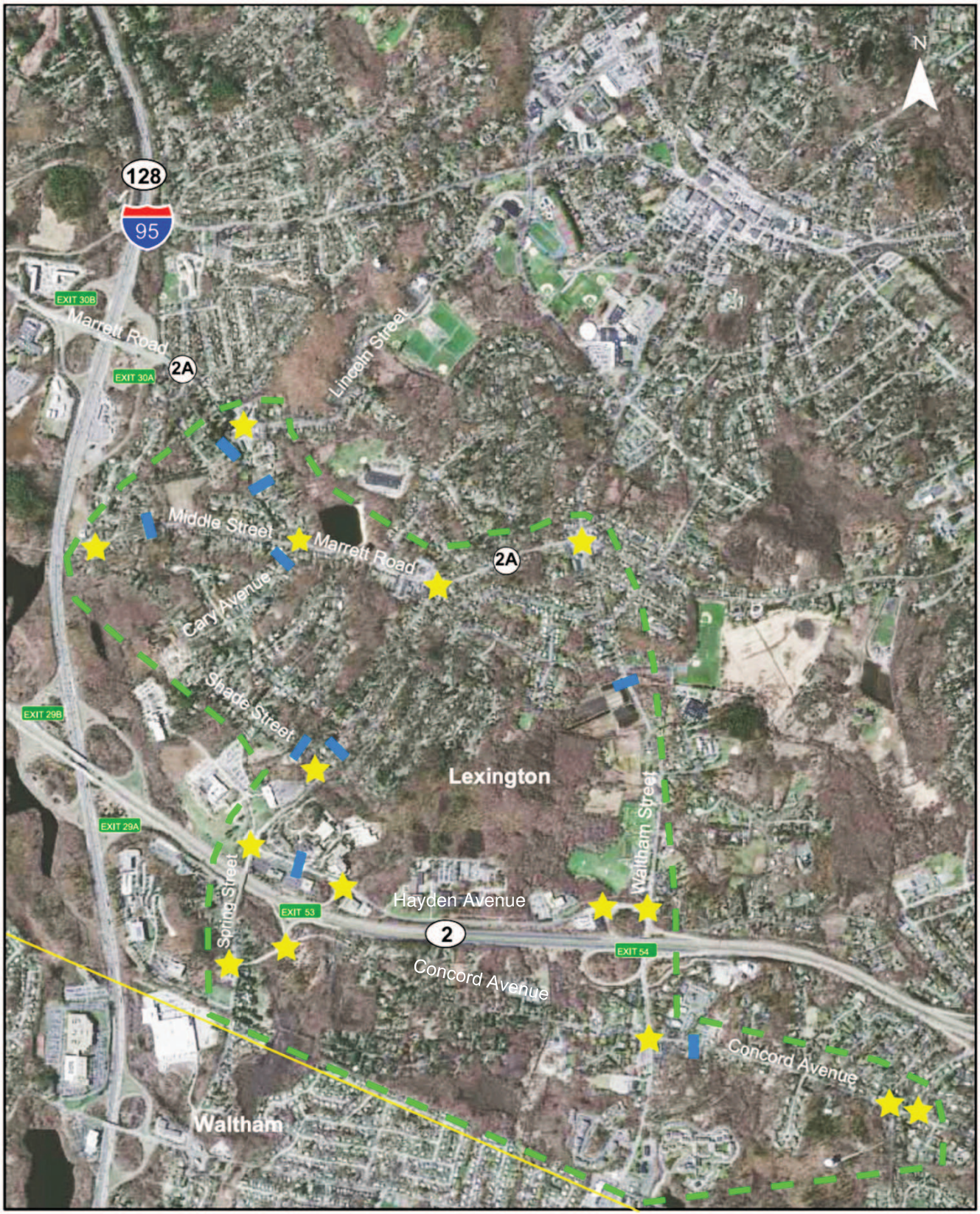

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Figure 2. 1– Study Area- Aerial Base

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Figure 2.1A – Study Area with Traffic Signals Identified

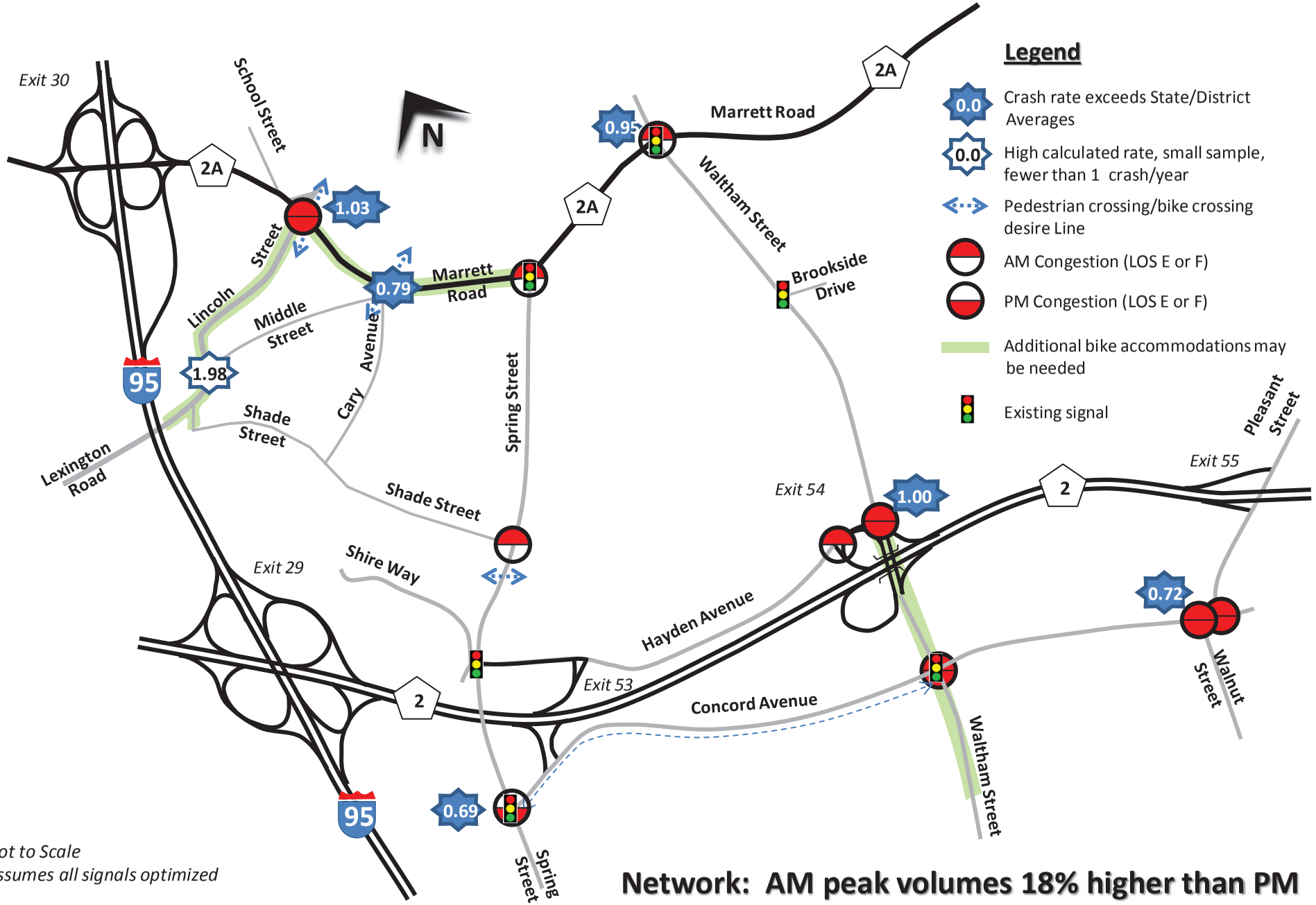

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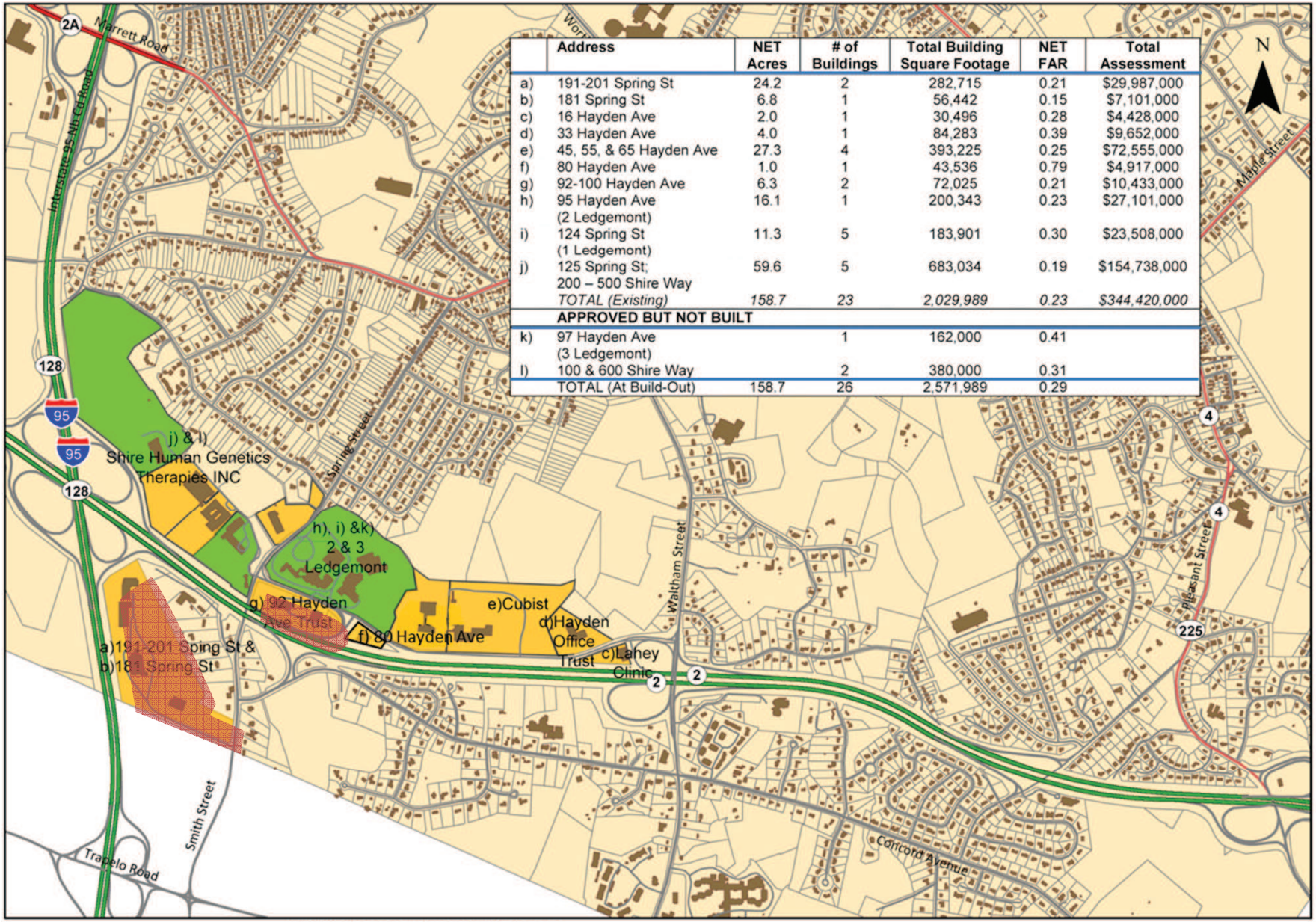
Figure 2.2 – Summary of 2013 South Lexington Traffic Problem Areas



	Address	NET Acres	# of Buildings	Total Building Square Footage	NET FAR	Total Assessment
a)	191-201 Spring St	24.2	2	282,715	0.21	$29,987,000
b)	181 Spring St	6.8	1	56,442	0.15	$7,101,000
c)	16 Hayden Ave	2.0	1	30,496	0.28	$4,428,000
d)	33 Hayden Ave	4.0	1	84,283	0.39	$9,652,000
e)	45, 55, & 65 Hayden Ave	27.3	4	393,225	0.25	$72,555,000
f)	80 Hayden Ave	1.0	1	43,536	0.79	$4,917,000
g)	92-100 Hayden Ave	6.3	2	72,025	0.21	$10,433,000
h)	95 Hayden Ave (2 Ledgemont)	16.1	1	200,343	0.23	$27,101,000
i)	124 Spring St (1 Ledgemont)	11.3	5	183,901	0.30	$23,508,000
j)	125 Spring St; 200 – 500 Shire Way	59.6	5	683,034	0.19	$154,738,000
	TOTAL (Existing)	*158.7*	*23*	*2,029,989*	*0.23*	*$344,420,000*
	APPROVED BUT NOT BUILT					
k)	97 Hayden Ave (3 Ledgemont)		1	162,000	0.41	
l)	100 & 600 Shire Way		2	380,000	0.31	
	TOTAL (At Build-Out)	158.7	26	2,571,989	0.29	

Individual parcels evaluated in the Hayden Avenue/Spring Street corridors

Parcels where additional development has been approved, but not yet fully built out

Potential density increase only with redevelopment

0 1,000 2,000 Feet

South Lexington Transportation Study Development Sites

South Lexington Transportation Study

Figure 2. 3 – Hayden/Spring Developments

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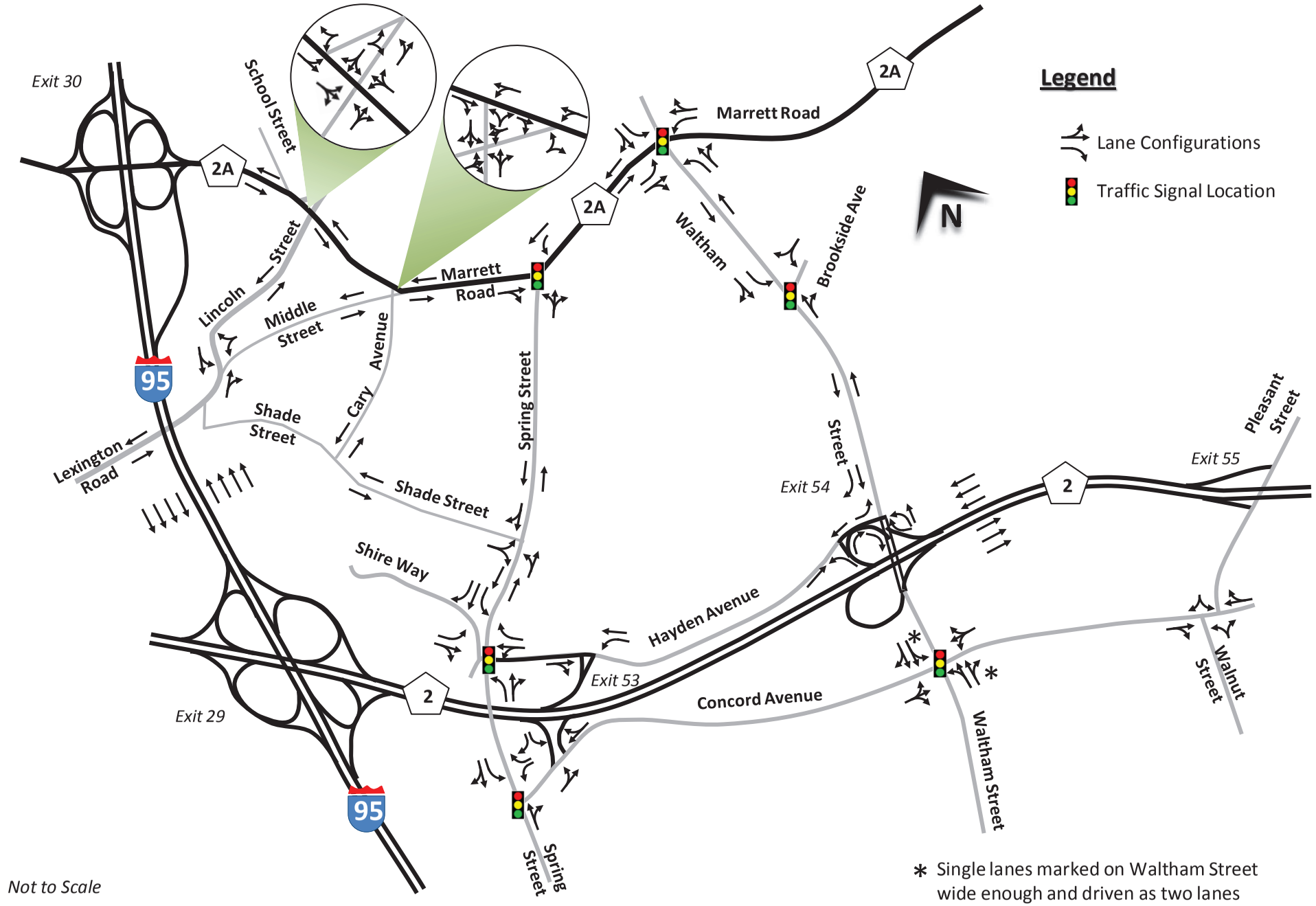

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Figure 2.4 - Existing Intersection and Corridor Lane Configurations

2.2 PROJECTION ASSUMPTIONS

Projecting traffic conditions for the South Lexington Study Area involves a five-step building block process.

First of all, the Town of Lexington provided a list of programmed infrastructure modifications and programmed development projects that may affect the multi-modal circulation system in the South Lexington Study Area.

Second, to estimate regional traffic growth unrelated to South Lexington growth areas, FST contacted Central Transportation Planning Staff (CTPS) to obtain a general background traffic growth rate for the South Lexington Study Area. This makes traffic projections somewhat conservative (high side) as the background traffic growth rate is assumed to represent CTPS's best approximation of growth from its regional traffic model *inclusive of development* within the Town of Lexington.

Third, traffic from approved but not yet constructed sites in the Hayden Avenue/Spring Street traffic growth areas was generated using the latest edition of the Institute of ITE Trip Generation report, 9th Edition (2012).

Fourth, FST distributed and assigned the traffic projected to be generated to the roadway network to represent the year 2023 moderate projected traffic conditions.

2.2.1 Programmed Transportation Facilities

Refer to Figure 2.5 for a summary of recent and programmed short term enhancements the Study Area transportation infrastructure. The Town of Lexington is continuing to implement measures that enhance the viability of the South Lexington Transportation network for all modes on its roadways as well as the trails traversing its extensive open space network of recreational parks and woods. Since this Study was initiated, a sidewalk has been implemented on the north side of Hayden Avenue. Other programmed measures within the South Lexington Transportation network include:

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Figure 2. 5 - Recent and Programmed Transportation Enhancements by 2023

2.2.1 Programmed Transportation Facilities (Continued)

- **Shade Street** traffic calming measures including a two-foot striped shoulder for pedestrians, no centerline, and bike shared use markings, or "sharrows" as well as recently implemented speed humps to reduce travel speeds.
- **Hayden Avenue** bike lanes on both sides were added during 2013, following up on the construction of a sidewalk on the north side of Hayden Avenue during 2012.
- **Concord Avenue** bike sharrows and a new sidewalk on its south side are to be implemented within the next few years.
- **Concord Avenue at Spring Street** signalization improvements are under construction and will be implemented within the next year.
- **Concord Avenue and Waltham Street** signalization and markings improvements are under design and are scheduled to be implemented within the next few years.
- **Route 2 ramps to and from Waltham Street** are being reviewed for potential design enhancements during the next few years. Since specific design elements have not yet been identified, this study identifies potential enhancements based on the existing intersection operations and crash analysis and a review of historical crashes and the potential for traffic growth.

Within the past few years, the Town restriped and resurfaced Spring Street including sharrows spaced 250 to 350 feet apart. As noted above, the Town recently implemented traffic calming measures on Shade Street, which has also recently been resurfaced. As on Spring Street, sharrows for Shade Street are spaced every 250 to 350 feet. Striped shoulders offset 3 feet from the edge of the road have been added to delineate pedestrian space on Shade Street. No centerline is being provided to alert motorists that they should carefully pass pedestrians and bicyclists, as they may encroach on the opposing traffic to do so. Following a door-to-door survey of residents regarding traffic calming features, the Engineering Department installed new speed humps and are considering constructing a sidewalk on Shade Street. These measures are outside the scope of this South Lexington study, but are noted as on-going projects.

2.2.2 Background and Programmed Traffic Growth

Central Transportation Planning Staff (CTPS) and nearby communities were contacted to obtain information on the potential for traffic unrelated to nearby developments in Lexington at the Hayden Avenue/Spring Street areas programmed for additional commercial development. As the regional planning agency, CTPS models traffic forecasts for eastern Massachusetts, including Lexington. It is interesting to note that between 2007 and 2011, vehicle miles traveled in Massachusetts urban areas *declined* by 0.02 percent overall. However, the CTPS model forecasts that a reversal of this trend will occur and that South Lexington VMT will slowly grow by 0.2% per year to approximately a 2-percent traffic increase over the next ten years by the year 2023. CTPS projects the 2-percent growth will account for both background *and* programmed development in the South Lexington study area.

Adjacent communities did not indicate there were any new area-specific programmed developments that will directly affect streets in the South Lexington study area.

To be conservative, FST assumed that background traffic growth would be increased by the traffic projected to be generated by new developments already programmed in the South Lexington area including:

1) 162,000 gross square feet (gsf) of new offices at 97 Hayden Avenue; and

2) 380,000 gsf of new offices at 100/600 Shire Way.

As stated in Technical Memo 1, FST was originally going to estimate both "moderate" and "high" end build-outs of the Spring Street/Hayden Avenue corridors. However, the "moderate" projections produced intersection LOS E/F at several intersections. After discussions with Town representatives, it was deemed that conducting a "high" end buildout, was an unreasonable exercise, as it would have resulted in traffic analysis conditions still more inconsistent with the Town's zoning guidelines which call for peak hour LOS's being in the range of A-D.

To estimate the traffic associated with the two above development sites – essentially the "moderate" buildout -- trip generation rates from the ITE Trip Generation report (9th Edition, 2012) were applied from the above programmed, but not yet constructed developments. See computations on Table 2.1.

Table 2.1
Trip Generation – Approved South Lexington Sites

	AM Peak Hour	PM Peak Hour
100/600 Shire Way	490 in	86 in
	67 out	418 out
	557 Total	**504 Total**
97 Hayden Avenue	248 in	44 in
	34 out	216 out
	282 Total	**260 Total**

Trip generation rate source: ITE Trip Generation, 9th Edition, 2012

The above trip estimates were compared to previous projections of the Shire, Ledgemont and Cubist facilities and found to be reasonably consistent. When approved developments within the South Lexington study area are completed, trips projected from Table 2.1 imply that during the AM and PM peak hours, the as yet unconstructed development will generate approximately 750-840 new AM or PM peak hour trips within the study area.

After comparing CTPS 2010 Journey to Work data with traffic distribution patterns developed by others and the 2012/2013 ground counts, the distribution patterns developed by BSC in 2008-9[1] for growth areas in South Lexington appeared to be reasonable and still applicable.

Figure 2.6 illustrates the trip distribution pattern used to distribute traffic from the development sites shown previously on Figure 2.3 and create the year 2023 moderate case for analysis. Figures 2.7 and 2.8 illustrate the AM and PM peak hour traffic volumes respectively projected for 2023 based on the background traffic growth plus full build out of the approved developments within the Spring Street/Hayden Avenue commercial development areas. In aggregate, Study Area traffic is projected to grow approximately 12% during the AM peak hour and 10% during the PM peak hour.

[1] *Traffic Impact Study Three Ledgemont Office Building*; BSC;2008
[2] *2000 Highway Capacity Manual*; Transportation Research Board
[3] A Guide on Traffic Analysis Tools; MassDOT February 2011

2.2.3 Moderate Year 2023 Traffic Projections and Peak Traffic Operations

All capacity analysis for the study area intersections in Lexington was performed in accordance with the methodologies set forth in the 2000 Highway Capacity Manual[2] using the SYNCHRO Version 7 software approved by MassDOT Highway Division[3]. Level of service (LOS) at signalized and unsignalized intersections is based on estimates of delay per vehicle. Table 2.2 presents a summary of the Level of Service criteria for unsignalized and signalized intersections.

Table 2.2
Intersection Level of Service Criteria

Level of Service	Unsignalized Delay (seconds/vehicle)	Signalized Delay (seconds/vehicle)
A	≤10	≤10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual, 2000

From Figures 2.7 and 2.8, traffic operations at the study area intersections were evaluated assuming all programmed infrastructure modifications are implemented and all remaining approved development along the Hayden Ave/Spring St corridors is constructed and occupied.

As noted above, the Town of Lexington zoning considers LOS's A-D as being representative of acceptable peak hour traffic operating conditions. Room for additional growth beyond approved development quantities could be possible within the Hayden/Spring Streets area if, at some time in the future, the Town modifies its zoning policy to assume that intersections, with mitigation can be returned to no-worse-than conditions found in the No-Build alternative, which may be LOS E/F. This would be similar to the MEPA environmental impact criteria.

Based on anticipated an assumption that programmed improvements will be place by 2023, the AM peak hour, as was found in the 2013 analysis, will continue to represent worst case conditions within the South Lexington Transportation Study area. Table 2.3 summarizes analysis results of year 2023 peak hour levels of service within the South Lexington Transportation Study area.

Table 2.3
South Lexington Intersections - 2023 Optimized Traffic Operations
With Programmed Improvements

Signalized Intersections with Optimized Timing

	2023 AM			2023 PM		
Intersecting Street Names	***Delay***	***LOS***	***V/C***	***Delay***	***LOS***	***V/C***
Marrett Road (Route 2A) at Waltham Street	74	E	1+	55	E	0.97
Concord Avenue at Spring Street*	46	D	1+	63	E	1+
Concord Avenue at Waltham Street*	63	E	1+	49	D	0.96
Hayden Avenue at Spring Street & Shire Way	82	F	1+	2+ min	F	1+
Marrett Road (Route 2A) at Spring Street	2+ min	F	1+	55	D	0.96

Unsignalized Intersections

	2023 AM			2023 PM		
Intersecting Street Names	***Delay***	***LOS***	***V/C***	***Delay***	***LOS***	***V/C***
Waltham Street at Rte 2 WB off right turn	76	F	0.95	95	F	1+
Concord Avenue at Walnut Street	48	E	0.69	18	C	0.39
Concord Avenue at Pleasant Street	2+ min	F	1+	79	F	0.96
Concord Avenue at Route 2 Eastbound Ramps*	2+ min	F	1+	18	C	0.53
Shade Street at Spring Street	2+ min	F	1+	18	C	0.28
Hayden Avenue at Route 2 Westbound On-Ramp	9	A	0.18	10	B	0.27
Hayden Avenue at Route 2 Westbound Off-Ramp LT	2+ min	F	1+	29	D	0.48
Hayden Avenue at Route 2 Westbound Off-Ramp RT	13	B	0.51	22	C	0.44
Hayden Avenue at Waltham Street	2+ min	F	1+	2+ min	F	1+
Lincoln Street North at Marrett Road (Route 2A)	14	B	0.37	12	B	0.18
Lincoln Street South at Marrett Road (Route 2A)	2+ min	F	1+	2+ min	F	0.85
Middle Street at Cary Avenue	10	A	0.09	20	C	0.21
Lincoln Street at Middle Street	13	B	0.24	9	A	0.02
Marrett Road (Route 2A) at Cary Avenue	24	C	0.16	18	C	0.18
Middle Street at Marrett Road (Route 2A)	14	B	0.08	11	B	0.05

Delay expressed in seconds per vehicle during peak 15 minutes of the peak hour. At high
LOS - Level of Service from A-F; A is best; F is worst. Signal LOS is overall; unsignalized LOS is for worst movement.

V/C - Calculated Volume to Capacity ratio.

Intersections with calculated peak hour LOS E/F congestion or 1+ V/C are highlighted in yellow.

* Assumes programmed signal and striping/geometric modifications.

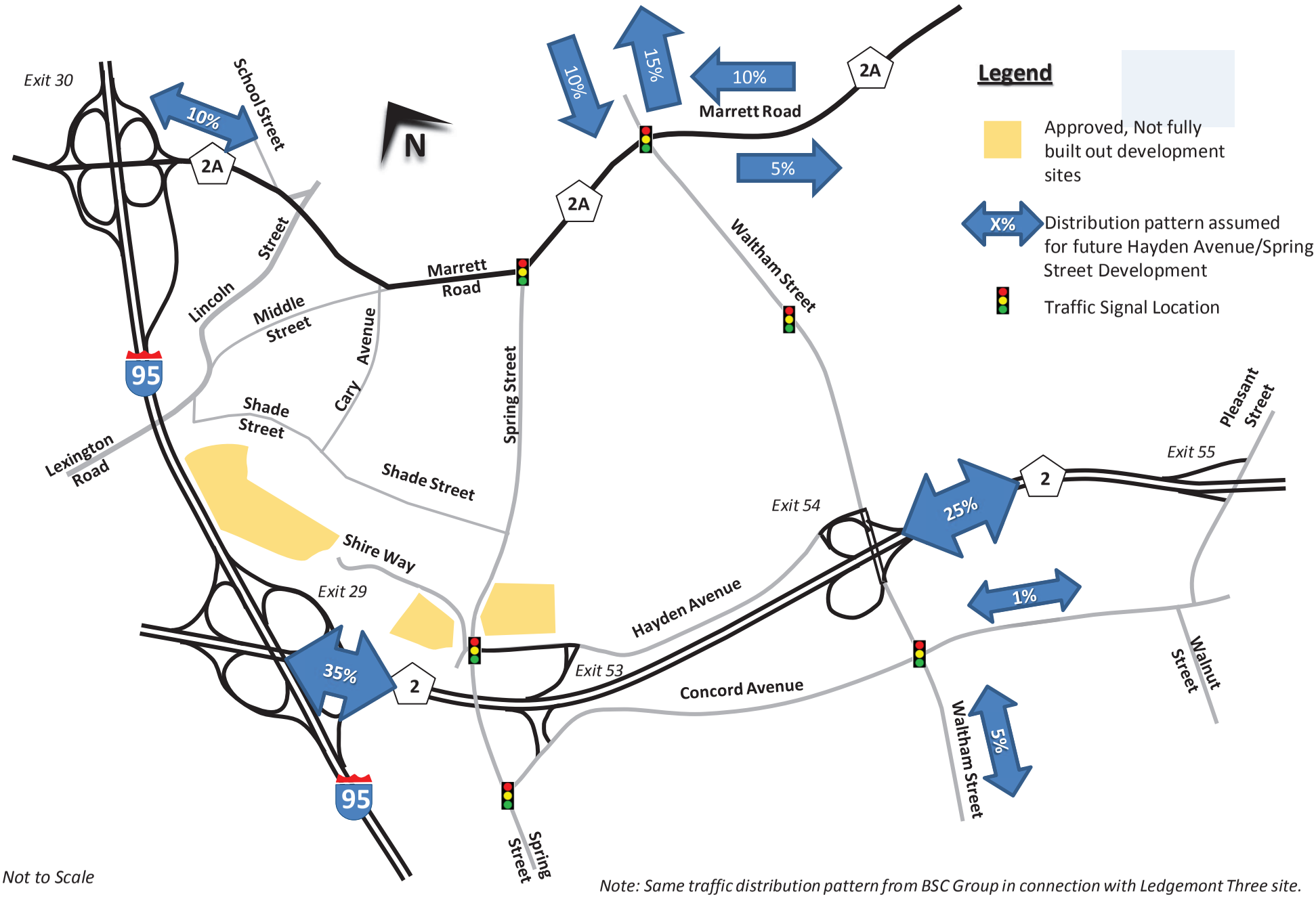

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Figure 2.6 – Projected Traffic Distribution Pattern of Approved Developments

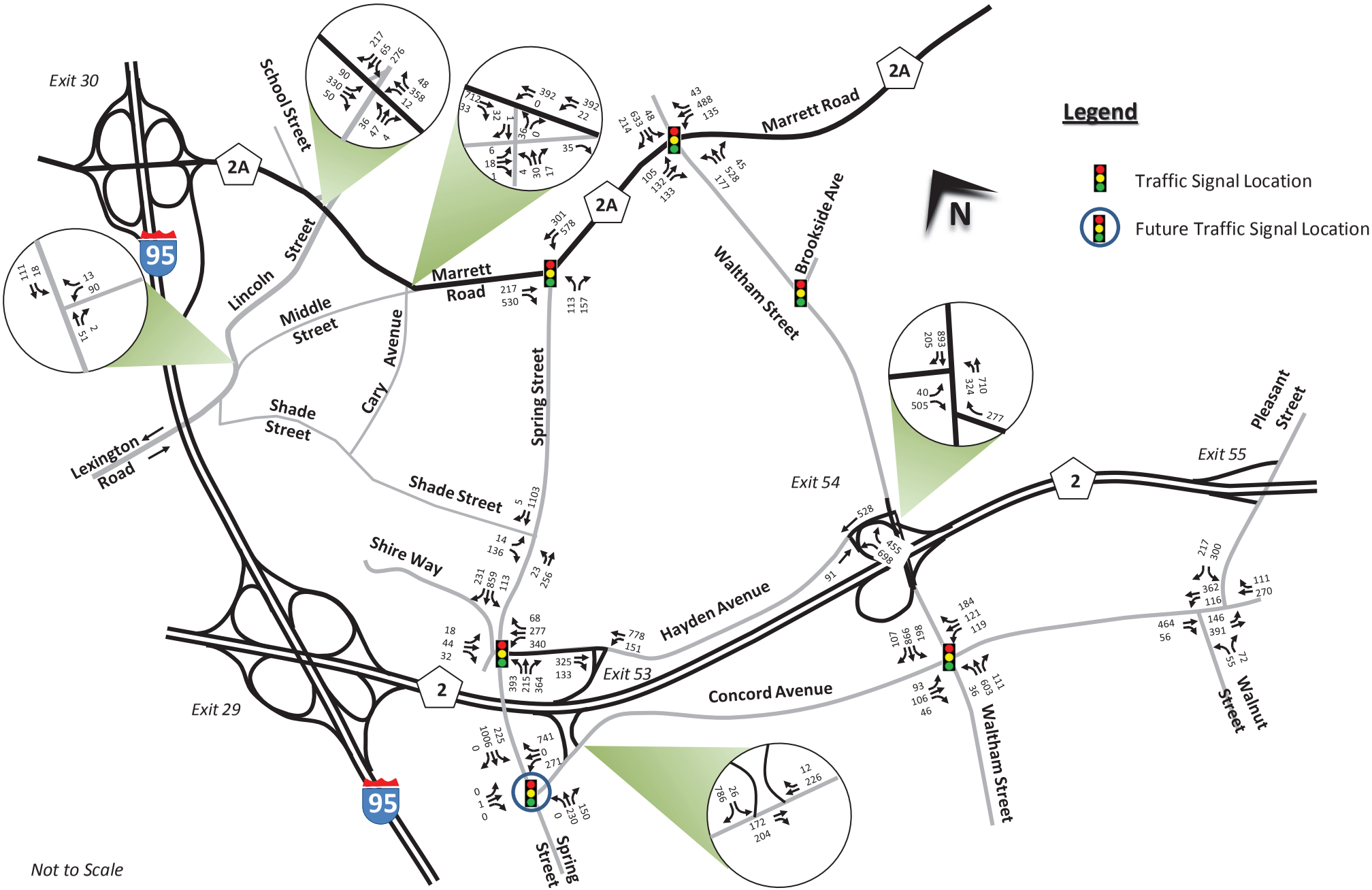

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Figure 2.7 - 2023 Projected 'Moderate' Growth – AM Peak Hour

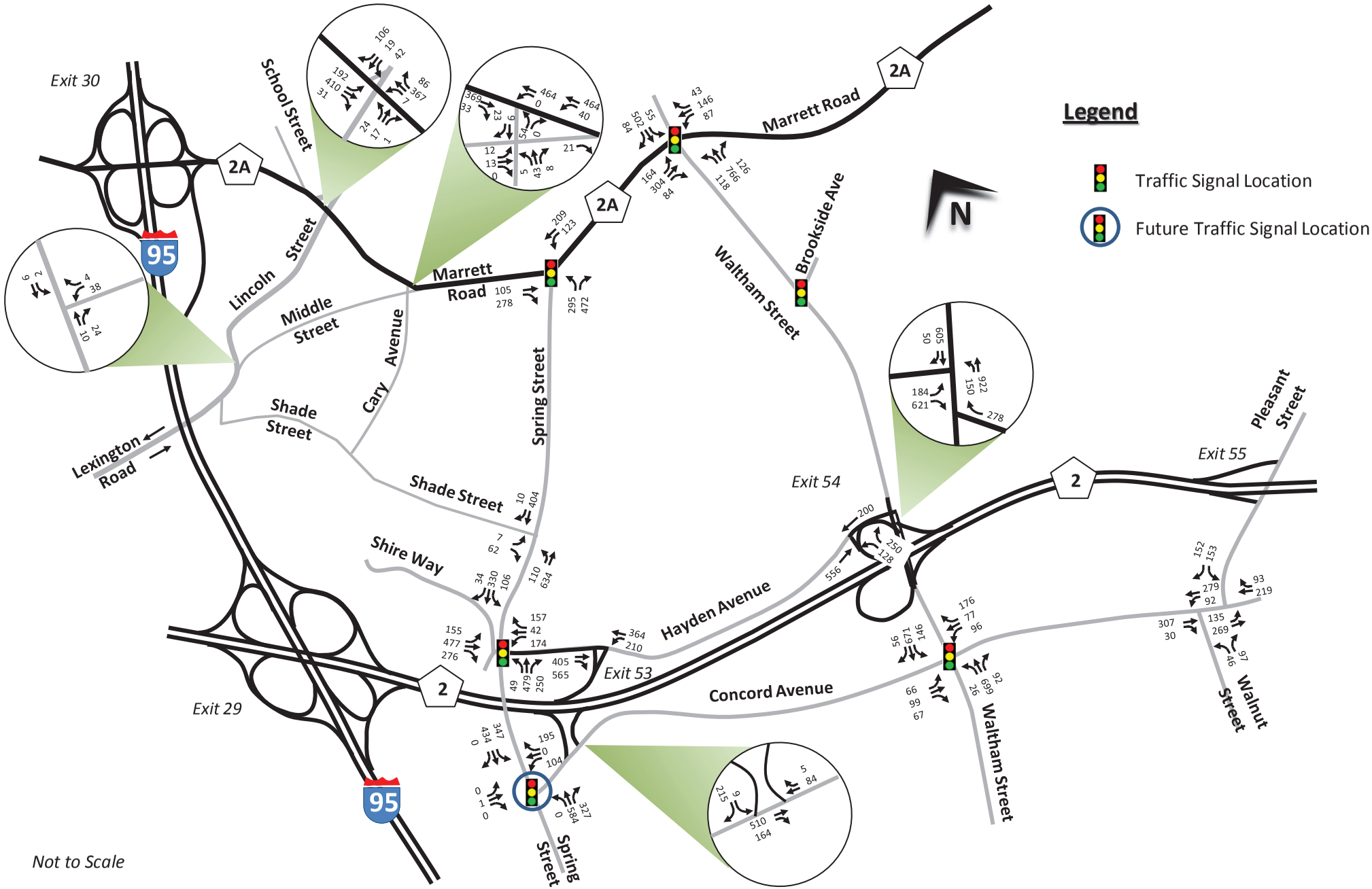

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Figure 2.8 - 2023 Projected 'Moderate' Growth – PM Peak Hour

2.2.3.1 AM Peak Hour Operations – 2023 estimates vs. 2013

Of the signalized intersections, with the exceptions of Concord Avenue at Waltham Street and Concord Avenue at Spring Street, all traffic signal controlled intersections will experience greater congestion during the 2023 AM peak hour than found in 2013. Of the five signalized locations, only Concord Avenue at Spring Street is expected to operate at an overall LOS D. Both Marrett Road at Waltham Street and Concord Avenue at Waltham Street are expected to be operating at an overall LOS E by 2023. This represents an improvement for the intersection of Concord Avenue at Waltham Street. Analysis indicates it was operating at LOS F during 2013. The intersection of Hayden Avenue at Spring Street and Shire Way will decline from an LOS D to LOS F by 2023. Marrett Road at Spring Street is expected to be operating at an LOS F in 2023, as it was in 2013, but with longer queues and delays.

Of the unsignalized intersections, congestion experienced at stop or yield controlled intersections during the AM peak hour will noticeably increase at:

- *Lincoln Street at Marrett Road (Route 2A)*. This stop controlled four way intersection has existing difficulties processing left and through movements. Increased congestion with longer queues and greater delays will occur as traffic grows in the future.

- *Hayden Avenue at Waltham Street*. Stop-controlled on the Hayden Avenue left lane approach, traffic operations at this intersection are compounded by the Route 2 WB exit merge onto Waltham Street just to the south.

- *Waltham Street at the westbound Rte. 2 off-ramp.* Projected LOS F operations here are compounded as some motorists seek to cross over to the left lane northbound on Waltham Street toward Hayden Avenue.

- *Concord Avenue at Pleasant Street.* The stop controlled Pleasant street approach will continue to experience long delays, as it does today with slightly higher traffic demands.

- *Shade Street at Spring Street.* Traffic on this stop controlled intersection will worsen, as right turn

demands, an undesirable product of cut through motorists, are expected to increase.

- *Concord Avenue at the Route 2 eastbound off-ramp.* Operating at an LOS D during 2013, the LOS for right turning traffic exiting Route 2 is expected to decline to an LOS F. At this location, the merge may not be as severe as indicated, given that the merging volumes are expected to be less than 1,100 vehicles per hour.

2.2.3.2 PM Peak Hour Operations – 2023 estimates vs. 2013

Similar to what was found during 2013, projected year 2023 PM peak hour operations at study area intersections will not be as congested as 2023 AM peak hour operations.

Of the signalized intersection, Marrett Road (Route 2A) at Waltham Street's operations are expected to worsen from an LOS D to E. Following signal and lane improvements, the Concord Avenue at Waltham Street, analyzed as an LOS F during the 2013 PM peak hour, will improve to LOS D. However, Hayden Avenue at Spring Street and Shire Way operations are expected to decline from LOS D in 2013 to LOS F in 2023. PM peak hour operations at the soon-to-be signalized Concord Avenue at Spring Street intersection will improve from LOS F to LOS E. With programmed improvements, the intersection of Waltham Street at Concord Avenue will operate at an overall LOS D, as opposed to its LOS F operations during 2013. While slightly more congested with longer queues, Marrett Road (Route 2A) at Spring Street will remain at an overall LOS D during the PM peak hour.

Of the unsignalized intersections evaluated, all will operate at LOS D or better with the exception of:

- *Hayden Avenue at Waltham Street*. Similar to the AM peak hour, the Hayden Avenue left lane approach will experience long delays compounded by the Route 2 WB exit merge onto Waltham Street just to the south.

- *Waltham Street at the westbound Rte. 2 off ramp.* Projected LOS F operations here are compounded as some motorists seek to cross over to the left lane northbound on Waltham Street toward Hayden Avenue.
- *Concord Avenue at Pleasant Street.* Similar to the morning peak hour, the Pleasant street approach will

continue to experience long delays, as it does today with slightly higher traffic demands.

- *Lincoln Street at Marrett Road (Route 2A).* Approaching Lincoln Street traffic on this four-way intersection will continue to experience long delays, though the volume to capacity ratio will be less than 1, indicating there is reserve capacity to accommodate the intersection's demands.

2.2.4 Future Safety Concerns with Moderate Year 2023 Traffic Projections

As documented in Technical Memorandum 1, during the most recently available five-year period from 2006 to 2010, statewide crash data reviewed within the South Lexington Study Area, reveals that crash rates exceeded either Statewide or District average crash rates at seven intersections, six of which had more than 1 crash reported annually. Ranked in order of the highest crash rates, the following four of the seven South Lexington Study Area intersections exceeded Statewide or District average crash rates for comparable intersections during the five-year period.[2]

- Marrett Road (Route 2A) at Lincoln Street (1.02 crash rate)
- Hayden Avenue at Waltham Street (1.00 crash rate)
- Marrett Road(Route 2A) at Cary and Middle Streets (0.79 crash rate)
- Concord Avenue at Walnut Street (0.72 crash rate)

Because traffic will increase by the year 2023, absent mitigation measures, the potential for crashes will also increase proportionally to increases in traffic volumes at locations where mitigation measures have not already been installed or are programmed for improvements.

1 Due to its low volumes, the intersection of Lincoln at Middle Streets experienced a relatively high crash rate of 1.98 per million entering vehicles, but fewer than one (1) crash per year with three reported crashes during a five year period, none during the most recent 2009/2010 reporting years. Additionally, while Concord Avenue at Spring Street (0.69 crash rate) and Marrett Road (Route 2A) at Waltham Street (0.95 crash rate) exceeded State or District average crash rates, both had mitigation signal upgrades installed after 2010.

With the exception of Marrett Road at Cary and Middle Streets, all the intersections cited above also experience congestion during the AM and PM peak hours.

Improving the safety of *all travel modes* is an important aspect of this study and is addressed in the Alternatives section of this Technical Memorandum.

Figure 2.9 identifies projected study area transportation issues that should be addressed over the next 10 years. The analysis finds that, for the most part, the Town has been addressing major circulation issues in the area. Unresolved issues are focused on roadways that are not controlled by the Town, primarily Marrett Road and the Route 2 interchange at Waltham Street.

2.2.5 Future Pedestrian and Bicycle Connectivity

- General

  Another key element of the South Lexington transportation study is the coordination with other Town committees, departments and groups to consider the implementation of bicycle and pedestrian amenities in the area. The Town has historically been very active in initiating improvement measures. This is evident with the shared lane markings (sharrows) placed on roadways throughout Town, new bike lanes, for example on nearby Hayden Avenue and some recent examples include new sidewalks such as along both Hayden Avenue and Spring Street, including handicap ramps. Included with the new sidewalk along Spring Street are new crosswalks and two (2) pedestrian signal devices to alert motorists of pedestrian crossing activities. On Concord Avenue in the South Lexington area, a new sidewalk is in the conceptual stage for the south side of Concord Avenue and on Shade Street some traffic calming devices were installed to accommodate pedestrian and bicyclists.

- Pedestrian Connections

  Coordination should occur with the "Across Lexington" program, which is a group to encourage walking and hiking across parts of Lexington through a full network of routes including conservation lands, recreational areas, general open space, school zones and roadway systems. Currently two major routes are identified on the web site (www.acrosslexington.org), one of which (Route B) covers a portion of the South Lexington area. This organization is an initiative of the Lexington Greenways Corridor Committee. The Greenways Corridor Committee also coordinates with the

Western Greenway, which is a walking/hiking path, parts of which are improved and unimproved, and passes through the Towns of Belmont, Lexington and Waltham. The Lexington portion of the Western Greenway crosses Walnut Street, just south of Potter's Pond Condominiums and there remain a multitude of possible connection opportunities.

With the current Across Lexington Routes, there are considerations that should be given to crossing public ways to provide safe crossing for mountain bikers and hikers and facilitate pedestrian connections. Locations in the South Lexington area that should be considered for a supplemental or new warning device, signing, pavement markings or if warranted a regulatory device include:

- Spring Street near Shire
- Spring Street, near Grassland Street
- Waltham Street near Hayden Avenue and
- Walnut Street, south of Potter Pond Road

At the Spring Street crossing near Shire, there already is a speed warning device in place, but no marked crossing area or signing. In some locations, an ADA ramp system should be accented, while at other locations, measures to highlight the street crossing could be enhanced. Some crossing locations could benefit from improved sight lines along the roadways, so motorists are aware of possible crossing activity to addition to signing or markings. There are numerous measures to improve crossing locations, many of which the Town is currently utilizing in other parts of Town. Many of these should be considered in the South Lexington network of trails and paths.

- Bicycle Connections

The most popular and busiest bicycle facility in Town is the Minuteman Commuter Bikeway. The Town has been very active in promoting the use of this facility as well as other parts of Town. In one of the project workshops for this project, it was indicated that there was a regular bike commuter group that identified a dis-connect of the bicycle network. There is an established bicycle advisory committee that has taken the lead with Town officials to promote bicycle safety and developing a network of routes. While the Town has been pro-active in recently accommodating bicycles such as the addition of bike lanes on Hayden Avenue, from

Waltham Street to Spring Street, and the addition of shared lane markings on Spring Street, there are other network opportunities the Town is investigating, such as the mechanism to use on Concord Avenue and continuation of the network on Spring Street to the south. Locations in the South Lexington area that should be considered for bicycle connections or improved connections include:

- Waltham Street
- Marrett Road
- Spring Street south
- Concord Avenue
- Lincoln Street

Wayfaring and guide signage should be included, not to just identify the bike route, but provide mileage destinations on the signing. In the alternatives section FST has provided some additional considerations for biking opportunities.

2.2.6 Future Mitigation Assessments and Allocations

Development projects in the South Lexington area typically come before the Town boards for approvals. These approvals could be for a change in use, a new project or an expanded site seeking additional permitted space. As part of the approval process, a mitigation package is developed in part with Town staff, the development team and occasionally state agencies such as MassDOT and the Boston MPO.

In working towards implementing mitigation strategies for these projects, Town staff is presenting investigating additional funding associated with already-permitted development once a project is constructed. This is part of the developer's MOU (Memorandum of Understanding) and becomes a key element for future infrastructure needs. The key objective with future development is to create a mechanism for correlating off-site mitigation with area needs, determining how the funds will be utilized, determining the sequence of implementation and internally determining how mitigation funds are distributed. A mechanism for prioritization of mitigation funds should be established. For example, the signalization of Shire Way/Spring Street and Spring Street/Concord Avenue have been discussed for decades and it was

only until recently that the intersections have become signalized to improve mobility.

Simply determining what the mitigation should be and where the mitigation funds are to be allocated is critical to enhancing mobility. A few considerations for determining priority of projects and use of mitigation funds are:

- Ranking of locations by accident rates, severity of damage and unacceptable operations;
- Proximity of future mitigation locations to sensitive land uses in the area;
- Benefit of mitigation to all users (improved level of service, enhanced mobility);
- Enhancement of transportation network connections to other parts of Lexington and surrounding communities;
- Coordination with Town Master Plan and programed Capital Improvement Program (CIP); and
- Emergency upgrade conditions.

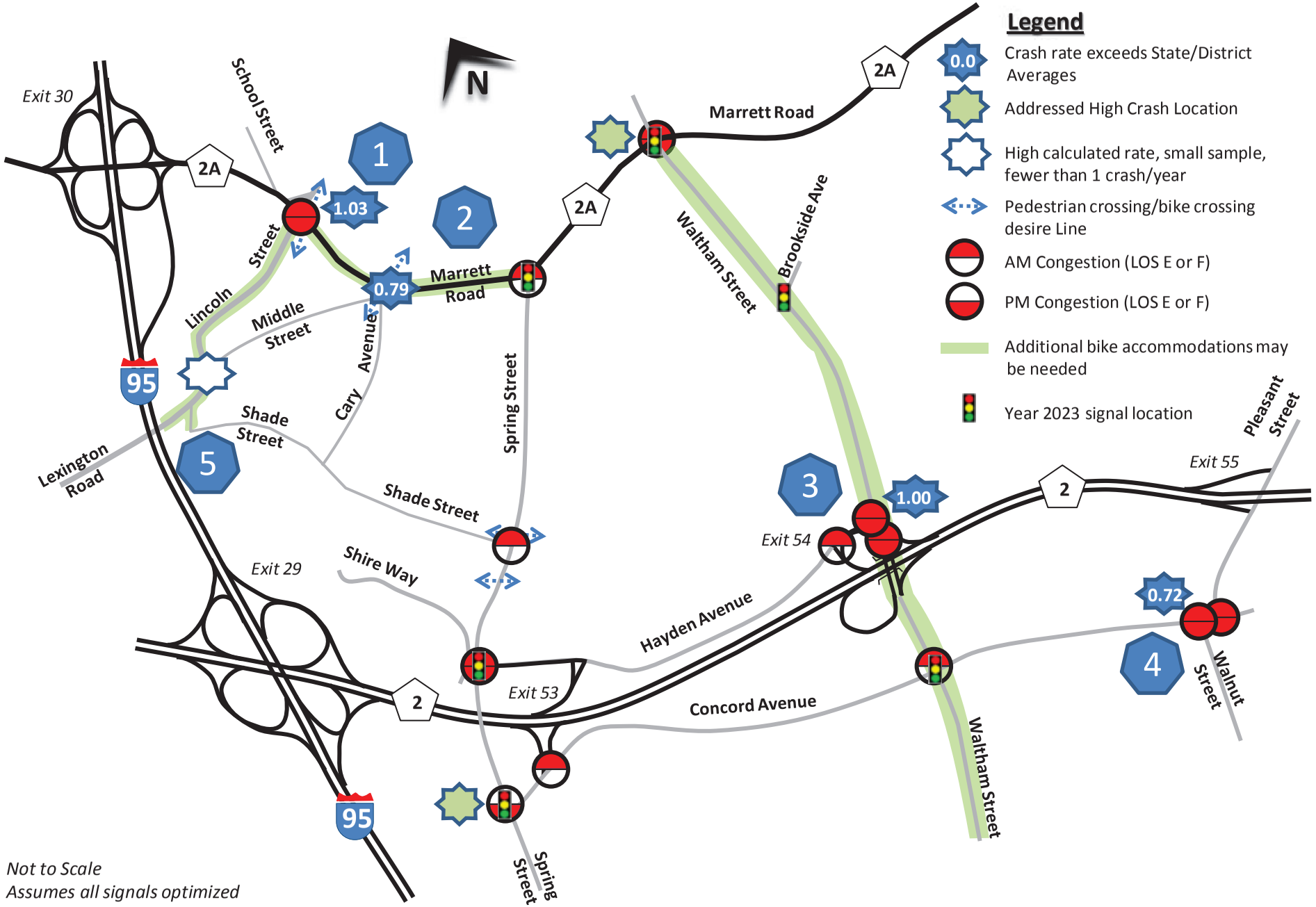

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Figure 2.9 – Year 2023 Focus Areas and Issues

2.3 ALTERNATIVE MITIGATION MEASURES

Based on the analysis findings of intersections and crashes, alternatives were developed for *unaddressed* issues highlighted on Figure 2.9.

From Figure 2.9, while the Town of Lexington and MassDOT have addressed most of the key issues, the most pressing needs for additional potential mitigation measures tend to be focused on intersections with MassDOT jurisdiction and thus would likely be required to go through the Transportation Improvement Program (TIP) and permitting process. In all the recommendations listed, any historical issues would need to be investigated. Based on the most congested and highest crash rate potential, we would suggest the following *additional* intersections/areas be addressed within the next ten years:

- Area 1 - Marrett Road (Route 2A) at Lincoln Street
- Area 2 - Marrett Road(Route 2A) at Cary and Middle Streets
- Area 3 - Hayden Avenue at Waltham Street and Hayden Avenue at the Route 2 WB off-ramp left turn lane (combined)
- Area 4 - Concord Avenue at Pleasant and Walnut Streets (combined)
- Area 5 - Lincoln at Middle Streets

2.3.1 Area 1 - Marrett Road (Route 2A) at Lincoln /School Streets

Unusual geometric features of this intersection, along with relatively high peak hour traffic demands are contributing to the congestion and high 1.03 crashes per million entering vehicles at this intersection. High pedestrian and bike crossing volumes also suggest this intersection should be considered for safety improvements.

Figures 2.10-2.13 are photos of the intersection, while Figures 2.14 to 2.16 illustrate three potential strategies for addressing observed issues. Three options were evaluated including:

Option 1 – Signalized with a One-way Lincoln North segment

Refer to Figure 2.14 for an overview sketch of this option. The main Lincoln Street at Marrett Road intersection would be controlled with a fully actuated traffic signal as peak hour and volume signal warrants would be met, and there have been 3 crashes involving cyclists and 10 angle crashes during the past five years. Single lane approaches would be retained. The north leg of Lincoln Street around the park would be converted to one-way westbound operation. The pavement of North Lincoln Street and School Street would be reduced. Sidewalks and green space would be added.

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Figure 2. 10

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Figure 2. 11

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Figure 2. 12

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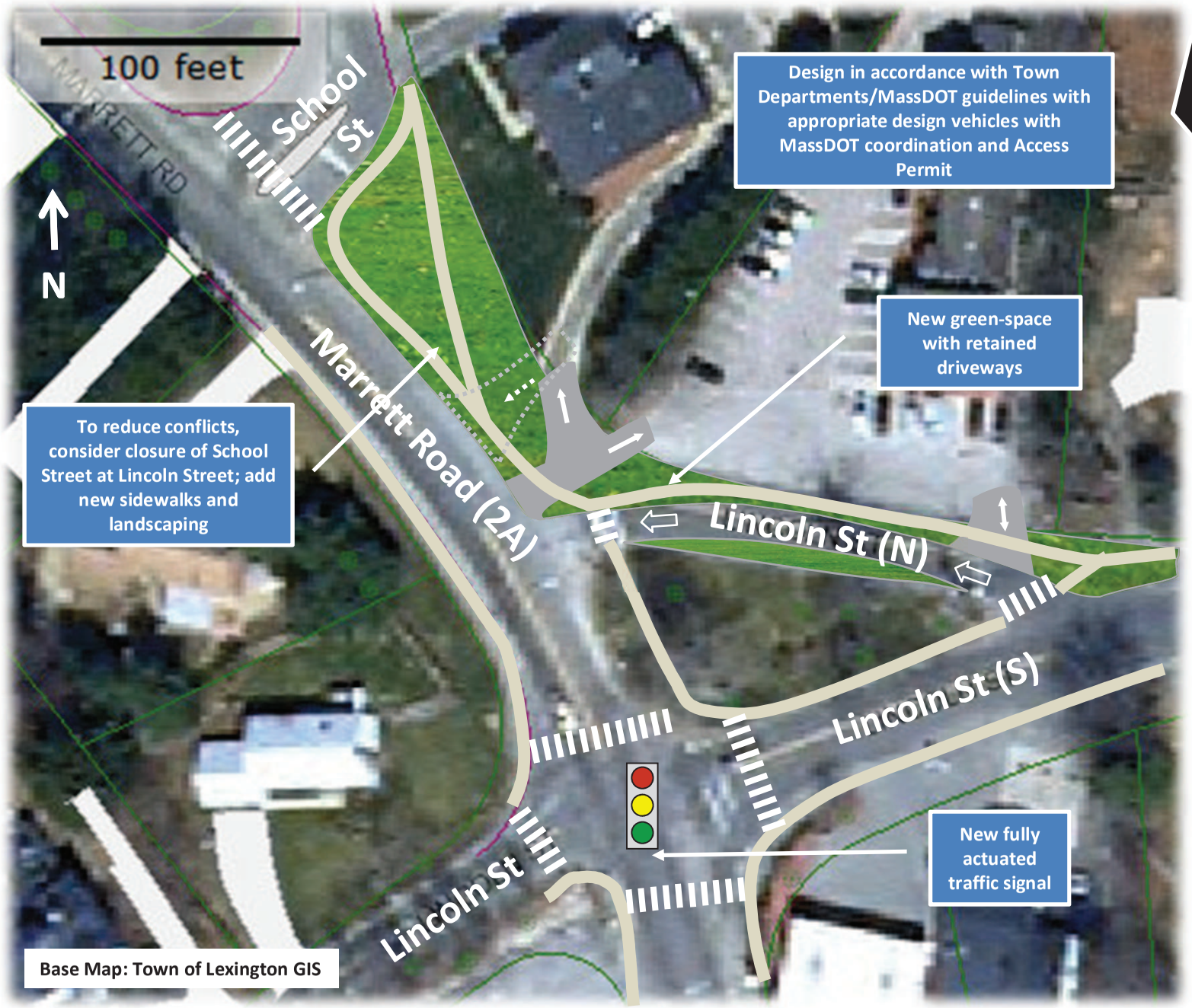
Figure 2. 13



Concept:
Not to Scale

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Figure 2.14 - Marrett Road (Rte. 2A) at Lincoln Streets
Option 1 – Signalized with One-Way Segment

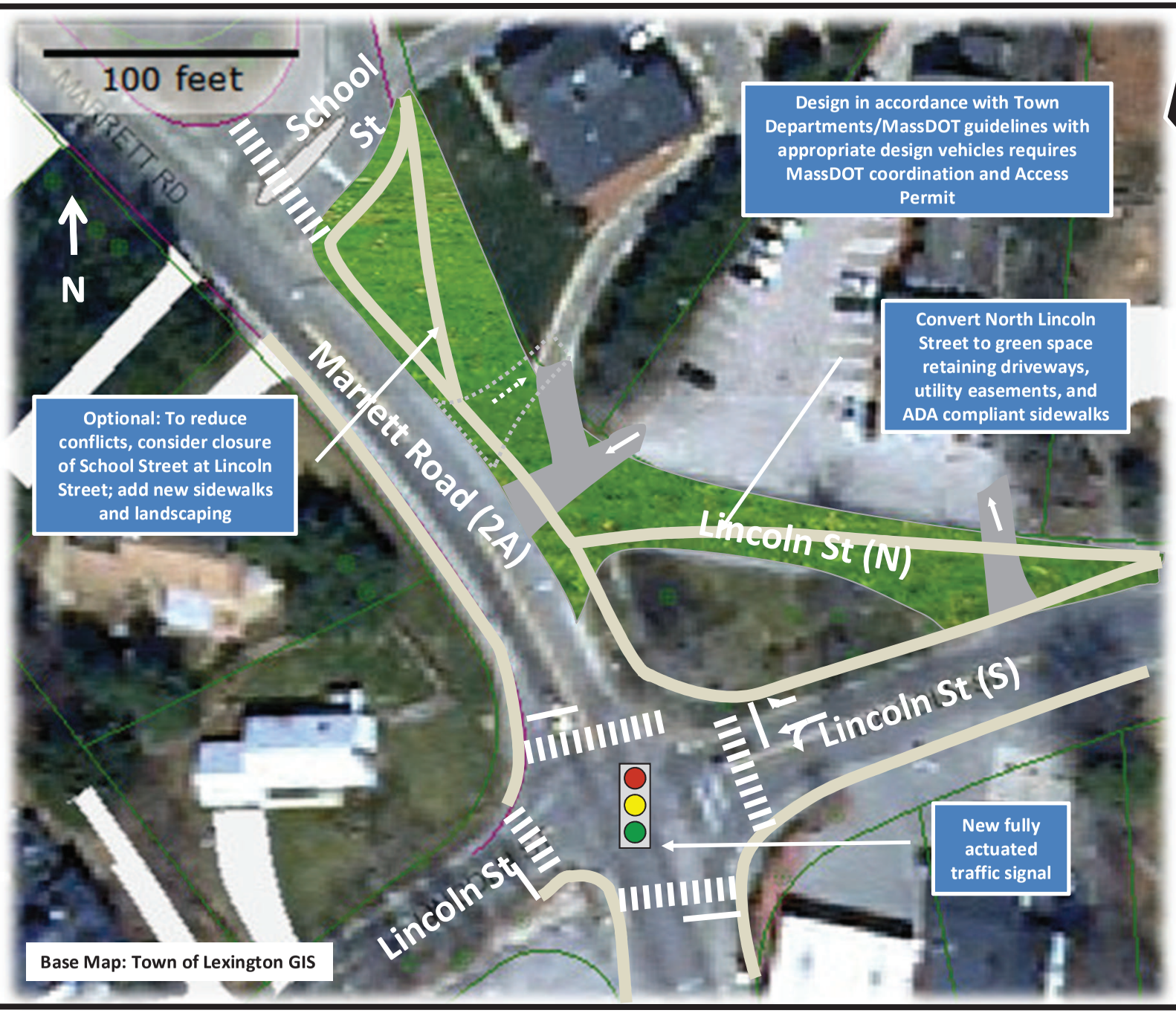

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Figure 2.15 - Marrett Road (Rte. 2A) at Lincoln Streets
Option 2 – Signalized with Enlarged Green Spaces

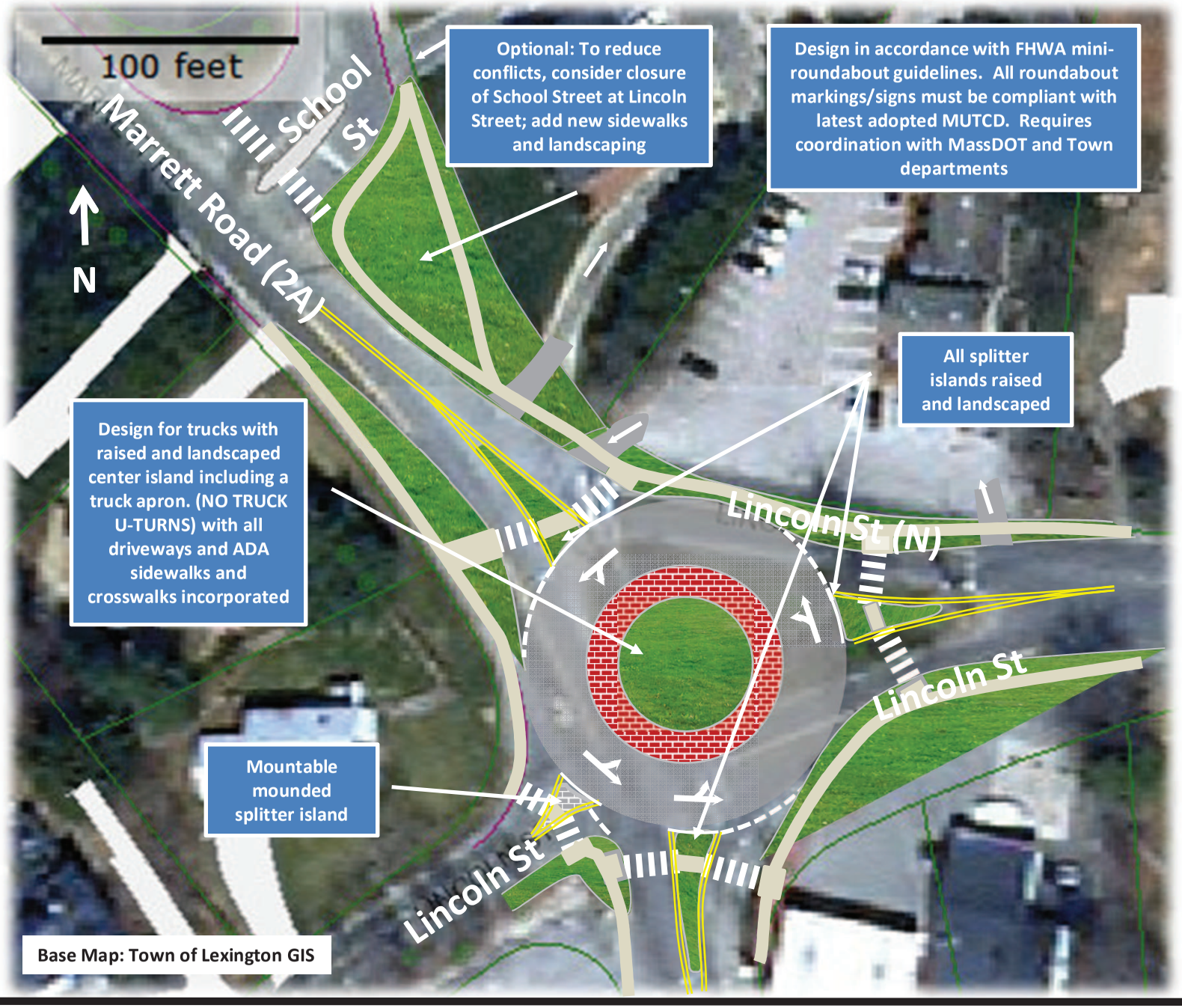

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Figure 2.16 - Marrett Road (Rte. 2A) at Lincoln Streets
Option 3 – Roundabout with Enlarged Green Spaces

2.3.1 Area 1 - Marrett Road (Route 2A) at Lincoln /School Streets (Continued)

Option 1 benefits:

- Enhances safety by reducing pedestrian/vehicle conflicts
- Enhances Marrett Road pedestrian/bike crossings
- Reduces overall peak hour congestion (LOS C or better)

Option 1 drawbacks:

- Estimated costs, $350,000 - $550,000
- Continuing signal maintenance costs
- Marrett Road motorist/bicycle delays greater than existing
- May reduce Marrett Road's attractiveness to through traffic
- Signalization may increase rear end collisions

Option 2 – Signalized with enlarged green spaces

Refer to Figure 2.15 for an overview sketch of this option. Like Option 1, the main Lincoln Street at the Marrett Road intersection would be controlled with a fully actuated traffic signal. Unlike Option 1, the north leg of Lincoln Street around the park would be converted to green space and the triangular park expanded. However, to operate without congestion, the westbound Lincoln Street approach, now accommodated by two separate approaches would require a relatively short left/through lane and an exclusive right turn lane. The pavement at North Lincoln Street and School Street would be reduced. Sidewalks and green space would be added.

Option 2 benefits:

- Enhances safety by reducing pedestrian/vehicle conflicts
- Enhances Marrett Road pedestrian/bike crossings more than Option 1
- Greener environment than Option 1
- Reduces overall peak hour congestion (LOS C or better)

Option 2 drawbacks:

- Estimated costs, $400,000 - $600,000
- Signal maintenance costs
- May increase rear end collisions at the new signal
- Marrett Road delays greater than existing

Option 3 – Roundabout with enlarged green space

Refer to Figure 2.16 for an overview sketch of this option. Unlike Options 1 or 2, the main Lincoln Street at the Marrett Road intersection would be controlled by a modern roundabout with a truck apron, splitter islands, and

crosswalks. Sidewalks and net new green space would be added, but significant park issues would need to be addressed.

Option 3 benefits:

- Roundabouts are a top-ten USDOT crash reduction measure
- Reduces pedestrian/vehicle conflicts
- Eases Lincoln Street traffic access to Marrett Road
- Enhances Marrett Road pedestrian crossings
- Reduces overall peak hour congestion (LOS C or better)
- Slows intersection vehicle conflicts
- Overall greater green space than "Do Nothing."

Option 3 drawbacks:

- Estimated costs, $450,000 - $600,000
- Adverse Lincoln North park impacts/tree impacts (requires relocation of established trees and park features to newly-created green spaces)
- May not be suitable on an arterial (MassDOT would need to approve) to maximize its attractiveness for through traffic
- Marrett Road traffic (including bicycles) requires slowing to negotiate the roundabout

Impacts of the three potential options were discussed with the Town/public on October 21, 2013. While none of the three potential options was particularly disliked or liked, some attendees liked the notion of enhancing the green space for the walking and biking environment compared to the "Do Nothing" alternative. Based on follow-up feedback with the Town, a recommendation will be made concerning a preferred strategy in Tech Memo No. 3.

2.3.2 Area 2 - Marrett Road (Route 2A) at Cary Avenue and Middle Street

Cary Avenue and Middle Streets criss-cross one another just south of this dual intersection with Marrett Road (Route 2A). Like the intersection of Lincoln at Marrett Road, we have developed a range of three options that might be considered to reduce crash rates at this intersection that has a pocket park and a multi-use path just north of the intersection. Figures 2.17-2.21 are photos of the exiting intersection, while three potential strategies for addressing observed issues are illustrated on Figures 2.22-2.25. The three options evaluated included:

Option 1 – Enlarge island and modify circulation

Refer to Figure 2.22 for an overview sketch of Option 1. New curb extensions and green space would be added to Middle Street and the segment of Cary Avenue between Marrett Road and Middle Street.